RTS2

Suite 6, Cookson House,
River Drive, South Shields,
Tyne & Wear.
NE33 1IX England

Tel: (091) 427 7774
Fax: (091) 427 5566

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1. TECHNICAL SPECIFICATION

1.1 OSCILLATOR

Frequency Range
15Hz to 150kHz in four ranges

Frequency Response
Flat within ± 0.2dB over the range 15Hz to 150kHz

Distortion
Less than 0.025% at 1kHz
Less than 0.08% over the range 100Hz to 20kHz

Maximum Output Level *
3V (approx.) into open circuit
Not less than +8 dBm into 600 ohm load

Output Attenuator
Coarse - Six steps of 10dB
Fine - Continuous over range of 15dB approx.
External - Fixed 40dB

Output Impedance
Independent of frequency
Dependent on setting of output attenuator coarse control:
always less than 450 ohms. From external 40dB attenuator 47 ohms

1.2 WOW & FLUTTER OSCILLATOR

Frequency
3.15kHz (Suffix A models, 3kHz)

Output Level
350mV approx.

Output Impedance
220 ohms approx.

1.3 MILLIVOLTMETER

Frequency Response
Flat within ± 0.2dB over range 10Hz to 150kHz

Accuracy
Within ± 2% f.s.d. over range 30Hz to 20kHz

Sensitivity
1mV to 100V f.s.d. in 11 steps of 10dB

* With the addition of an Auxiliary Test Set Unit, up to +20dB into 600 ohm load.

Input Impedance
2 Megohms (approx.) NOTE :No D.C. path between the input leads.

Indication
Average reading meter scaled in romose values for sinusoidal signals

1.4 WOW & FLUTTER METER

Type of Measurement
Meter measures peak wow and flutter weighted to DIN 45507

Input Signal Required
3.15kHz (Suffix A models 3kHz) at level not less than 7SmV

Normally this is supplied by the Fixed Frequency Test Signal Generator of the Test Set itself (see 1.2 above)

If the test signal is from another source, e.g. a pre-recorded test disc or tape, then the frequency of the test signal should be within t 5% of the nominal value.

Sensitivity
Three ranges for wow and flutter measurements :0.1%,0.3%& 1% fsd
One range, direct reading for drift measurements : t 2% fsd.

Input Impedance
50,000 ohms approx.

Frequency Response for Wow and Flutter Measurements
Maximum at 4.0Hz : 6dB points at 0.8Hz and 20Hz

Alternative Output
The signal measured by the meter also appears on a BNC socket on the front panel and can be fed to an external oscilloscope, wave analyser, filters, etc.

The output level is 3V (approx.) for meter f.s.d. from a source impedance of 15,000 ohms.

1.5 DISTORTION METER

Type of Measurement
Rejection of fundamental by a tuned filter.

Input Signal Required
Frequency within the range 400 to 1100Hz (approx.) Signal normally supplied by the Variable Frequency Test Signal Generator (see 1.1 above)

The level of the signal from the equipment under test should be 100mV or more. Smaller inputs may be used but with an increased minimum distortion reading.

Second Harmonic Rejection
Less than 0.25dB

Minimum Reading (from a distortionless source)
Less than 0.05%

Bandwidth of Harmonic Distortion Measurement
15Hz to 20kHz

There is an optional L.F. cut (turnover 400Hz) for the rejection of hum and other L.F. noise components.

Input Impedance
100,000 ohms approx.

Alternative Output
The signal measured by the meter also appears on a BNC socket on the front panel and can be fed to an external oscilloscope, wave analyser, filters, etc.

The output level is 1V (approx.) for meter f.s.d. from a source impedance of approximately 500 ohms.

1.6 GENERAL

Power Supply
105- 120 V, 50 or 60Hz or 200 - 250 V, 50 or 60Hz; 12 watts approx.

Dimensions
17 3/8 in. (441 mm) wide
10 in. (254 mm) deep over handles
5 5/8 in. (143 mm) high

Weight
13 lb (5.9 kg) approx.

Access
Access to the inside of the case is obtained by removing two screws from the underside of the lip above the back panel.

2. OPERATING INSTRUCTIONS

2.1 CONNECTIONS

2.1.1 Power Supply

Check whether the voltage selector at the back of the Test Set is set to the appropriate voltage range, 105-120V or 200-250V. If it is not, pull the selector knob outwards, rotate it to the required position and then press it home again firmly but gently. (On later models, see Section 3.3)

No adjustment for supply frequency in the range SO-60Hz (approx.) is required.
The power lead attached to the Test Set should be connected, through an appropriate plug, to the power supply (AC only).

The Test Set is switched on and off by turning the "SUPPLY" knob at the right of the front panel. The meter is illuminated to show when power is applied.

2.1.2 Signal

The BNC socket marked "oscillator" should be connected to the input of the equipment under test

If the external 40dB Attenuator is required, the 'flying'
lead should be connected to the "oscillator" socket and the connecting cable to the Attenuator.

The BNC socket marked "meter" should be connected to the output of the equipment under test.

Note 1. Cables for connecting the Test Set to the Line Input and Line Output sockets of a Ferrograph Series 7 recorder are supplied. These leads are irreversible and ensure that the 'earthy' sides of the Test Set and the recorder input and output circuits are connected together. When other leads or other end connectors are used, care must be taken to ensure that this condition still obtains.

Note 2. Since the Test Set has a common earth path between input and output sockets, great care should be taken to ensure that this does not result in a small part of the audio output current flowing through the input earth. When high-sensitivity inputs are being used, this could give rise to spurious noise or distortion readings. These can usually be prevented by the insertion of a small resistor (e.g. 100 ohm) in series with the "meter" input earth lead.

2.2 CALIBRATION

2.2.1 General

For this purpose it does not matter whether the Test Set is connected to the equipment to be tested or not. It is recommended, however, that the power supply should have been switched on for at least 5 minutes before calibration in the Drift and the Wow and Flutter modes is checked.

The adjustments are not interdependent and can be carried out individually.

2.2.2 Millivoltmeter

(1) Set the "MILLIVOLTMETER" switch to the "1V" position.
(2) Press down the "read input" button. (This releases the button to its left and the three buttons to its right).
(3) Press down the "CALIBRATE" button.
(4) The meter pointer should now lie on the CAL mark above the outer scale; if not, adjust the screwdriver-operated control "mV meter cal (1V range)".
(5) Press the "CALIBRATE" button to release it.

Note When this adjustment has been carried out with the "MILLI-VOLTMETER" switch in the "1V" .position, the meter measures voltage on the top scale with full scale deflection of 1V. Movement of the "MILLIVOLTMETER" switch adjusts the meter sensitivity to give full scale deflection for inputs of lmV to 100V, as indicated on the switch, reading on the appropriate one of the two upper scales.

For setting the meter to read arbitrarily, see 2.3.4 below.

2.2.3 Drift

(1) Press down the "W&F drift" button. This releases the two buttons on either side and applies a 3.15kHz * test signal to the "oscillator" socket and to the meter circuits.
(2) Press down the "CALIBRATE" and "W&F drift" buttons (thus releasing the "1%","0.3%", and "0.1%" buttons).
(3) The meter pointer should now read 0 on the "drift %" scale; if not, adjust the screwdriver-operated, pre-set control marked "drift set zero".
(4) Press down the "CALIBRATE" button to release it. The meter now measures drift directly on the "drift %" scale.

2.2.4 Wow and Flutter

(1) With the "W & F drift" button still pressed (see above), press the "CALIBRATE" and "0.3%" buttons (releasing the "drift, "1%" and "0.1%" buttons).
(2) The meter pointer should now lie on the CAL mark above the top scale; if not, adjust the screwdriver-operated pre-set control marked "peak wow cal (0.3% range").
(3) Press down the "CALIBRATE" button to release it.

The meter now reads percentage wow and flutter (0.3% f.s.d.) on the next to top scale. Pressing down the "1%" or "0.1%" button releases the "0.3%" button and the meter then reads percentage wow and flutter on the top scale with f.s.d. 1% or 0.1%

2.3 MEASUREMENTS

2.3.1 Preparation

In the following it is assumed that the gain controls on the equipment under test have been set for normal operating conditions. It is also assumed that the input and output signal voltages under these conditions are known, at least approximately. If not, then initially the OSCILLATOR OUTPUT coarse" switch should be set to its lowest (10mV) position and the "MILLIVOLTMETER" switch to its highest (100V) position. When connecting to a microphone input socket, the external 40dB Attenuator should be inserted between the Test Set and the equipment under test (see 2.1.2)

The "OSCILLATOR OUTPUT coarse" control should then be turned clockwise, step by step, until a proper operating level has been obtained. If this requires the "OSCILLATOR OUTPUT coarse" control to be set higher than 3V, then the 40dB Attenuator should be removed from the output.

With a proper output level from the equipment under test, the "MILLIVOLTMETER" switch on the Test Set should be turned anti-clockwise step by step, until a convenient reading on the meter is obtained.

2.3.2 Frequency Response

(1) Set the "OSCILLATOR OUTPUT coarse" switch to an appropriate position (see 2.3.1 above) and the "OSCILLATOR OUTPUT fine" control to about mid-position.

(2) Set the "FREQ" control to 100 and press down the "FREQUENCY" range button "x 10".

The Test Set is now delivering a 1kHz test signal to the equipment under test. The level of this signal can be controlled in steps by the "OSCILLATOR OUTPUT coarse" control and continuously by the "OSCILLATOR OUTPUT fine" control. Once set at 1kHz, these must not be varied throughout the rest of this test.

(3) Press down the "input" button and check that the "LF cut" and "CALIBRATE" buttons are both released.

The Test Set now measures the output voltage from the equipment under test (see Note to 2.2.2) .

(4) The frequency of the test signal is changed by means of the "FREQ" control and the range selecting buttons below it. The output level at various frequencies is read on the meter, its sensitivity being increased or decreased by use of the "MILLIVOLTMETER" switch (see Note to 2.2.2)as necessary.

A plot of output voltage against frequency shows the frequency response of the equipment under test.

Note 1. When making frequency response and similar measurements, it is usually convenient to have the meter reading 0 on the dB scale (or some other round number) at a chosen frequency, say 1 kHz. Normally this is done by using the "OSCILLATOR OUTPUT fine" control to adjust the level of the input signal to the equipment under test or by fine adjustments of its gain control.

When neither of these things can be done, as, for example, when reproducing a pre-recorded tape on equipment with no output level control, the meter may be adjusted to a convenient reference value by pressing down the "DISTORTION set 100%" button (thus releasing the "input" button) and adjusting the meter to the required reading by use of the "DISTORTION METER set 100%" control. The meter now indicates relative levels e.g. in decibels, at the various frequencies but it does not, of course, read in volts/millivolts.

The "MILLIVOLTMETER" control should only be used on the distortion meter ranges of "0.3%" to "100%". In view of the extreme sensitivity (10011V) of the "0.1%" range, this should not be used for reading voltages with the. "DISTORTION 100%" button pressed.

Note 2. When making frequency response measurements on magnetic tape recorders, it is essential that the input signal level be at least 20dB below that which gives full level recording at 1kHz. Similar restrictions on the permissible level of test signals apply to some other types of equipment.

Note 3. When testing a tape recorder that cannot record and reproduce simultaneously, it is necessary first to record a series of test frequencies (with a fixed input signal level) and then to measure output levels at the various frequencies when this recording is reproduced.

The above procedures measure the overall response of a tape recorder. To determine whether the reproducing frequency response is correct, it is necessary to measure the output levels at various frequencies when reproducing a standard test tape on which the various frequencies have been recorded to the appropriate Standard.

2.3.3 Drift

(1.) Press down the "W & F drift" button and also the "drift" button under "WOW & FLUTTER".

The Test Set now delivers a 3.1.5kHz* signal to the recorder under test.

(2) Set the recorder controls so that this signal is recorded at a normal level for, say, 40 seconds. Stop the machine, and rewind the tape to the beginning of the recording.

(3) Reproduce this recording.

Note. The level of the signal reaching the Test Set should not be less than 75mV. To check this, see Note 1 to 2.3.4.

(4) The meter now indicates directly on the "drift %" scale the percentage difference between the frequency of the reproduced signal and the 3.1SkHz* test signal that was recorded.

* On models Suffix A the internal oscillator is set to 3kHz.

Note When testing a disc reproducer it is necessary (and when testing a tape reproducer it may be convenient) to reproduce a test recording made on another machine. The indicated percentage drift may then be due partly to a difference in the recording and reproducing speeds and partly to the original signals not having been 3.1SkHz*.

2.3.4 Wow and Flutter

(1) If not already made, first prepare a test recording as in (1) and (2) of 2.3.3 above.
(2) Press down the "1%" button under the "WOW & FLUTTER" heading (releasing the "drift" button) and reproduce the test recording (see Note 1 below).

The meter now indicates wow and flutter on the top scale; f.s.d. 1%. If the meter reading is inconveniently small, press down the "0.3%" or "0.1%" button (releasing the "1%" button); the meter now indicates wow and flutter on the next to top scale with f.s.d. 0.1%.

Note 1. For proper operation of the limiter (which ensures that amplitude variations do not affect the readings), the reproduced voltage reaching the Test Set should be more than 75mV. This can readily be checked by pressing down the "MILLIVOLTMETER read input" button (releasing the "W & F drift" button) and determining the level from the combined readings of the meter and the "MILLIVOLTMETER" switch (see Note to 2.2.2)After such a level check, the "W &F drift" button must, of course, be pressed down again to measure wow and flutter.

Note 2. For a proper measurement of wow and flutter, the frequency of the signal fed to the Test Set should be within about ±5% of the nominal value, 3.15kHz*. When reproducing a test recording just made on the same machine as above, it will almost always be within the ±2% indicated directly on the "drift% scale. This may not be the case when reproducing a test recording made on a different machine or at another time but satisfactory measurements of wow and flutter can still be made if, when measuring drift, the meter can be made to read within its ±2% range by use of the "drift set zero" control.

Note 3. Readings of wow and flutter taken while the test recording is being made usually give a fair indication of magnitude but do not give true values since speed fluctuations that repeat in a period corresponding to the time taken by the tape to move from the record to the replay head do not appear.

2.3.5 Distortion

For this measurement, the output signal from the equipment under test should preferably be greater than 100mV (see Note 3 below).

The procedure is as follows:-
(1) Set the "MILLIVOLTMETER" switch to "1V".
(2) Set the "FREQ" control to 100 and press down the range selecting button marked "X10".

A 1kHz test signal is now delivered to the equipment under test.

(3) Press the "DISTORTION set 100%" button.
(4) Now use the "DISTORTION METER set 100%" control knob to adjust the meter to read 10 on the top scale.
(5) Press the DISTORTION read" button (releasing the "DISTORTION set 100%" button. Also press down the "LF cut" button.
(6) Set the "DISTORTION METER BALANCE fine" control to about mid-position (vertical) and then use the "freq-coarse" and "phase" controls to reduce the meter reading to a minimum.

During this process, the meter sensitivity should be progressively increased by means of the "MILLIVOLTMETER" switch to maintain a convenient reading. Complete the adjustment for minimum reading by use of the "freq-fine" and "phase" controls.

(7) The percentage distortion can now be read on the appropriate one of the two upper scales in combination with the % markings on the "MILLIVOLTMETER" switch.

Note 1. The test signal need not be 1kHz but it should be within the range 400-1100Hz, approximately. Otherwise, a minimum will not be obtained within the range of the "BALANCE" controls.

Note 2. The meter reading includes signals of all frequencies between 30Hz and 20kHz except for the test frequency and a narrow band on either side of it. It therefore includes hum and other low frequencies. Pressing down the "LF cut" button cuts the lower frequencies progressively below 400Hz.

Note 3. If a level of 100mV or more cannot be obtained from the equipment under test, it will not be possible to adjust the meter to full scale deflection as in (4) above. The measurement may still be carried out but with the "MILLIVOLTMETER" switch set below 1V, with a corresponding allowance in the calculation of percentage and with a restriction in the lowest level of distortion that can be measured.

Note 4. When testing a tape recorder that cannot record and reproduce simultaneously it is, of course, necessary first to record the test signal and then to measure distortion while it is being reproduced.

2.3.6 Signal-to-Noise Ratio

(1) With the equipment under test working at normal operating levels, measure the total harmonic distortion on a 1kHz test signal as in 2.3.5 above.

(2) If the total harmonic distortion is less than 2%, then increase the level of the test signal by means of the "OSCILLATOR OUTPUT" "coarse" and "fine" controls, (or, if testing a tape recorder, the recording gain control) until the distortion is 2%.

Note : A good idea of the rate of increase of distortion with signal level can be obtained by successively decreasing meter sensitivity and increasing signal level in steps of 10dB but, for the final determination of distortion, the full procedure of 2.3.5 should be carried out.

(3) With the equipment under test adjusted so that total harmonic distortion of a 1kHz output signal is 2%, press the "MILLIVOLTMETER input" button (releasing-the "DISTORTION read" button).
(4) Adjust the "MILLIVOLTMETER" switch to give a convenient meter deflection. The reading of the meter, in combination with the switch (see Note to 2.2.2),indicates the output level at which there is 2% distortion.
(5) Remove the signal from the input of the equipment under test and apply a short circuit.(But see Note 2 below).
(6) Press the "LF cut" button to release it.(But see Note S below).
(7) Increase the meter sensitivity, by means of the "MILLIVOLT-METER" switch, until a convenient reading is obtained. The number of millivolts indicated by the combined meter and switch readings (see Note 2.2.2) is the total noise level. The ratio of this to the voltage determined in (3) above, is the Signal-to-Noise Ratio, usually stated in decibels.

Note 1. When determining the 2% distortion level of a tape recorder, care must be taken that the gain controls are so set that the distortion does not arise primarily because of overloading of the electronics. This could happen, for example, because of an excessive input level compensated by a low setting of the recorder gain control or because of an excessive output level.
It is the condition when the distortion arises primarily in the record/replay processes that is usually referred to when the signal-to-noise ratio of a tape recorder is quoted.

Note 2. In the case of a tape recorder, there are several different signal-to-noise ratios that may be considered significant, according to circumstances, but in all cases it is necessary first to determine the output level at which the total harmonic distortion of a 1kHz test signal is 2% (see (1),(2) and (3) above).

It is with this output level that the various noise levels are usually compared. (But see Note 3 below).

The signal-to-noise levels most usually quoted are those obtained by:-

(a) recording and reproducing simultaneously with the input short circuited and using a bulk-erased or virgin tape;

(b) as (a) but using a tape previously recorded to saturation level;

(c) reproducing only, using a bulk-erased or virgin tape;

(d) reproducing with the tape stationary.

In each case the noise level must be measured under the stated conditions.

Note 3. Signal-to-noise ratios are sometimes reckoned from the 3% rather than from the 2% total harmonic distortion level or from a specified tape flux level.

Note 4. Signal-to-noise ratio measurements are made with various types of meter (e.g. r.m.s. or peak indicating) sometimes with and sometimes without a frequency weighting. This Test Set measures unweighted noise using an average reading meter scaled in r.m.s. values for sinusoidal signals.

Note 5. When it is tape hiss or other high frequencies that are of most interest it will usually be convenient to make the noise measurement with the "LF cut" button pressed down.

2.3.7 Gain

(1) First proceed with steps (1) , (2) and (3) of the procedure for measuring frequency response, 2.3.2. above.
(2) Press the "MILLIVOLTMETER read input" button and then adjust the "MILLIVOLTMETER" switch to obtain a convenient reading on the meter.
This reading, in combination with the switch, indicates the output voltage of the equipment under test. (see Note to 2.2.2)
(3) Now, press the "MILLIVOLTMETER read osc" button. This releases the "read input" button and connects the meter to indicate the output voltage-from the Test Set oscillator, i.e. the input voltage to the equipment under test.
(4) Adjust the "MILLIVOLTMETER" switch to obtain a convenient reading on the meter.

This reading, in combination with the switch, indicates the input level to the equipment under test.

The ratio of the output level (2) above, to the input level (4) above, is the gain of the equipment. It may be expressed as a numerical ratio or in decibels.

Note : Gain can be measured at any frequency desired by an appropriate setting of the "FREQ" control and the range selecting buttons. Care must be taken, however, to avoid overloading. (see Note 2 to 2.3.2.above).

3. MAINTENANCE

3.1 GENERAL

No regular maintenance is necessary on the Test Set other than occasional cleaning of the fascia and plate. A damp cloth should be used, and persistent stains may be removed using a weak solution of a mild detergent.

3.2 REMOVAL OF BOARDS

Access to the plug-in boards is obtained by removing the two screws ('A' in Fig.12 Exploded View) and sliding back the top panel; access to the underside is by removing the two screws ('B' in Fig.12 Exploded View) and sliding back the bottom panel. The board fixing strap is removed by undoing one screw at each end.

With certain boards it is necessary to remove the extension spindles by undoing the grub screws in the couplers using a 6BA Allen key. Most interconnections are by plug-in connectors but some are by soldered connections and these will
have to be unsoldered if the board or component is to be removed completely.

3.3 POWER SUPPLY VOLTAGE SELECTION (Serial No. 4515 onwards)

On models Serial No. 4515 onwards, the rear panel voltage selector mentioned in Section 2.1.1 is not fitted and adjustment to correspond to the power supply voltage is done internally.

Access is obtained by removing the two screws ('A' in Fig.12 exploded view, Appendix 4) and sliding back the top panel. On the power supply transformer Tl (see Fig. 10), the Brown/ White lead should be unsoldered and resoldered appropriately; tag 2 - 110V, tag 3.- 220V or tag 4 - 240V. The Blue/White lead should remain on tag 1. The rear panel must be marked with the new voltage.

No adjustment is necessary for supply frequency in the range 50-60Hz approximately.

4. TECHNICAL DESCRIPTION / FAULTS

4.1. OSCILLATOR (VT1-3)

The oscillator uses three transistors in a Wien Bridge circuit, comprising two gain stages VT1 and VT2 with an emitter follower stage VT3 to provide a low impedance output. Negative feedback for A.C. stabilisation is provided by the potential divider network Thermistor TH1/Resistor R7 to VT1 emitter and the D.C. conditions are stabilised with feedback via R3/R6. The frequency of the oscillator is set by the two parts of RV20 a& b in conjunction with C8-11 and C4-7 respectively as selected by the Frequency Range switch SW15.

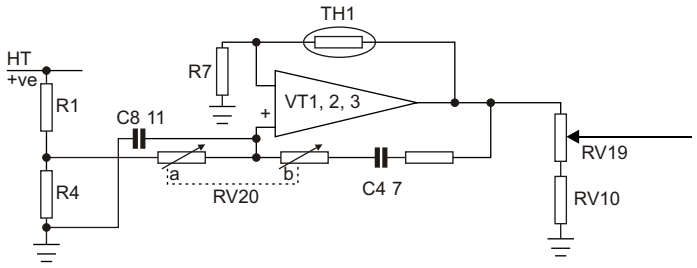


Fig. 1. Circuit Detail - Oscillator

FAULT	POSSIBLE CAUSES
High output with excessive distortion (squared off)	Thermistor TH1 faulty-open circuit (very low ambient temperature can cause TH1 to give this symptom). Transistor failure
No output	Transistor failure
Frequency calibration wrong (all ranges)	Dial setting disturbed - reset at 14kHz. C1 faulty (open circuit)
Frequency calibration wrong (on only one range)	Poor switch contact SW15. Appropriate capacitor faulty: x 1 C7 or C8 x10 C6 or C9 x100 CS or C10 x1000 C4 or C11
Low frequency modulation on highest freq. range (x 1000)	Transistor noisy. Resistor R5 noisy.
Calibration of ranges wrong (not 10dB per step)	Resistor burnt out in attenuator chain-probably R15 or R16 N.B. This is probably caused by DC signal fed into the oscillator output socket from the external connection-check before reconnecting.

4.2. MILLIVOLTMETER (VT51-57)

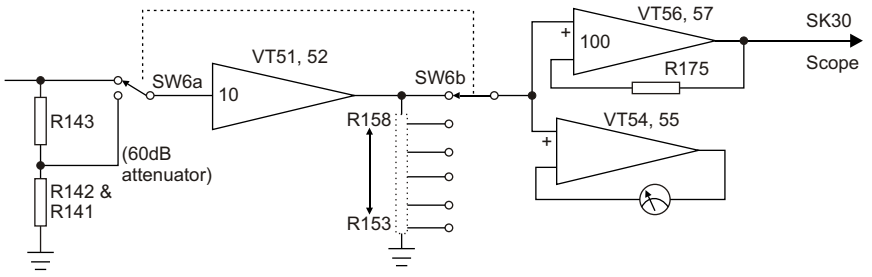
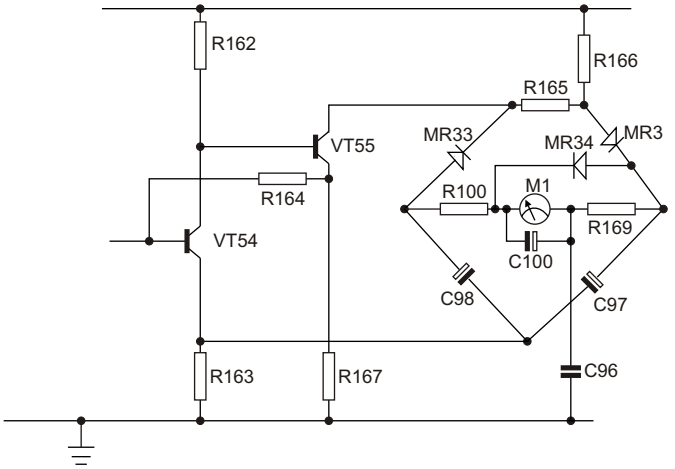


Fig. 2. Circuit Detail - Millivoltmeter

The signal is fed via blocking 'capacitor C89 and overload protection resistor R144 with R143 & R142/141 providing 60dB attenuation as selected by SW6a, which thus doubles the ranges selected by SW6b. Zener diode MR31 protects VT51 (not normally conducting) which is a field effect transistor giving a high input impedance. The overall gain of the first stage VT51 & 52 is determined by the feedback resistor R150, which is effectively from VTS2 collector to VT51 emitter (source), and the exact gain (approx. 10) is set by RV152 ('mV meter cal'). The main attenuator (R153-158) has six steps (10dB per step) selected by SW6b, and these are doubled by the 60dB attenuator SW6a to give 11 x 10dB steps and an earthed position. Emitter follower VT53 is a unity gain buffer stage, feeding two separate amplifier stages. The 'scope' amplifier VT56 & 57 has feedback applied by R175, and the output signal is fed to the 'scope' output except when the 'W&F drift' button is pressed. The second amplifier is the main amplifier VT54 & 55 for the meter itself, the meter being connected as part of the negative feedback loop in a half bridge configuration as shown. R165 provides biasing for the diodes MR32 & 33 to help the low signal linearity, and MR34 is a protection diode. C96 improves the extreme high frequency response.

Fig. 3.
Circuit Detail-Meter



The overall frequency response of the millivoltmeter circuit on the 300mV range or lower, should be level, but on the 1V range and higher, trimmer C83 is adjusted to give a level response (set on the 1V range). This may be done using the RTS oscillator as a source by pressing the 'Read Osc' button. Any leads should be removed from the 'meter' and ‘osc’ sockets to avoid the effect of their capacitance.

The steep LF cut, which is 3dB down at approx. 400Hz, is applied to the circuit in three places, the final response being as shown in Fig. 4.

(a) Normally the coupling capacitor from VT52 collector is C87 with C88 shorted. With the 'LF cut' button pressed, C87 is in series with C88 reducing the effective capacitance and attenuating the bass frequencies.

(b) Similarly C94 is normally short-circuit but with the 'LF cut' button pressed it is in series with coupling capacitor C93 thus reducing the capacity and hence the bass response.

(c) Normally the emitter of VT55 is decoupled by C99 in parallel with C9S. With the,'LF cut' button pressed C99 is removed from earth and only C95 is in circuit. This reduces the capacity and hence the bass response.

Fig. 4 L F Cut Response (Typical)

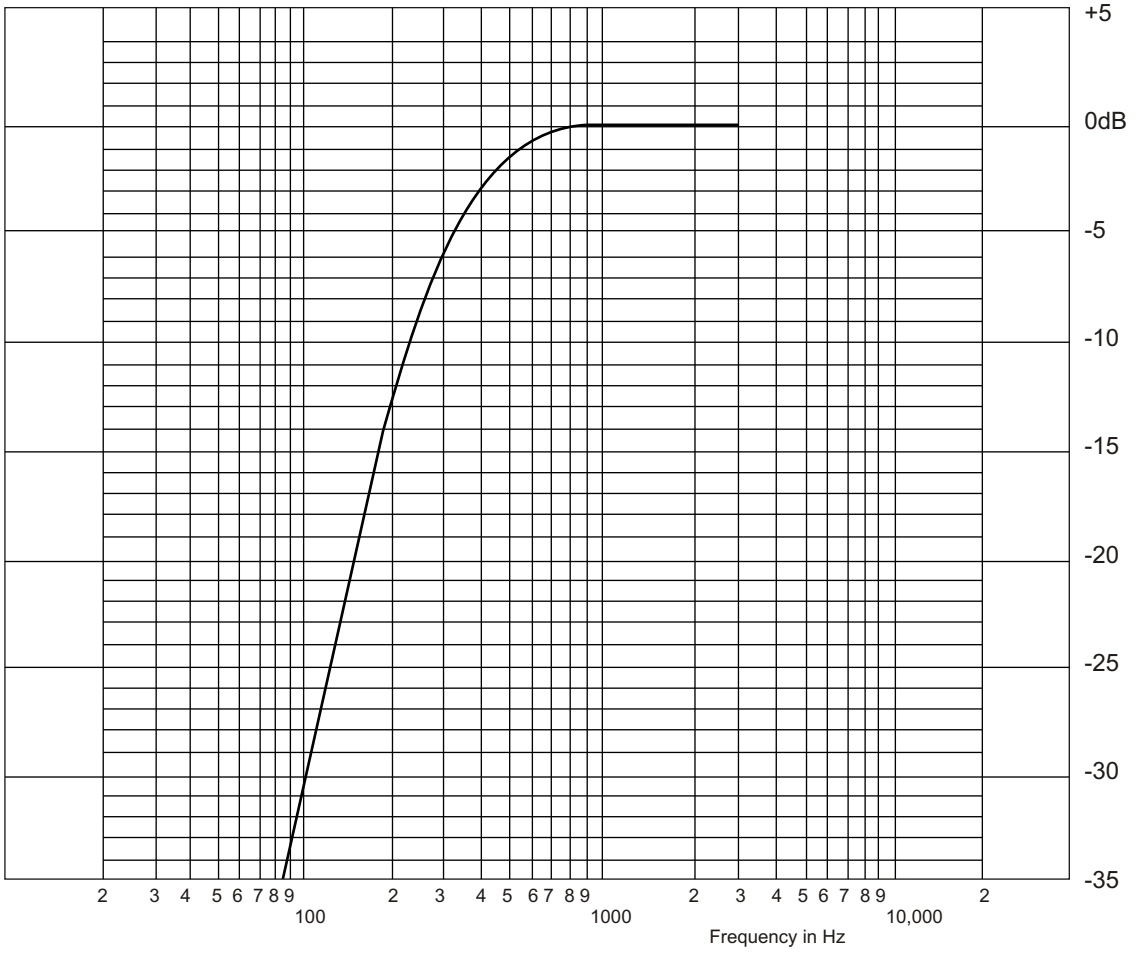
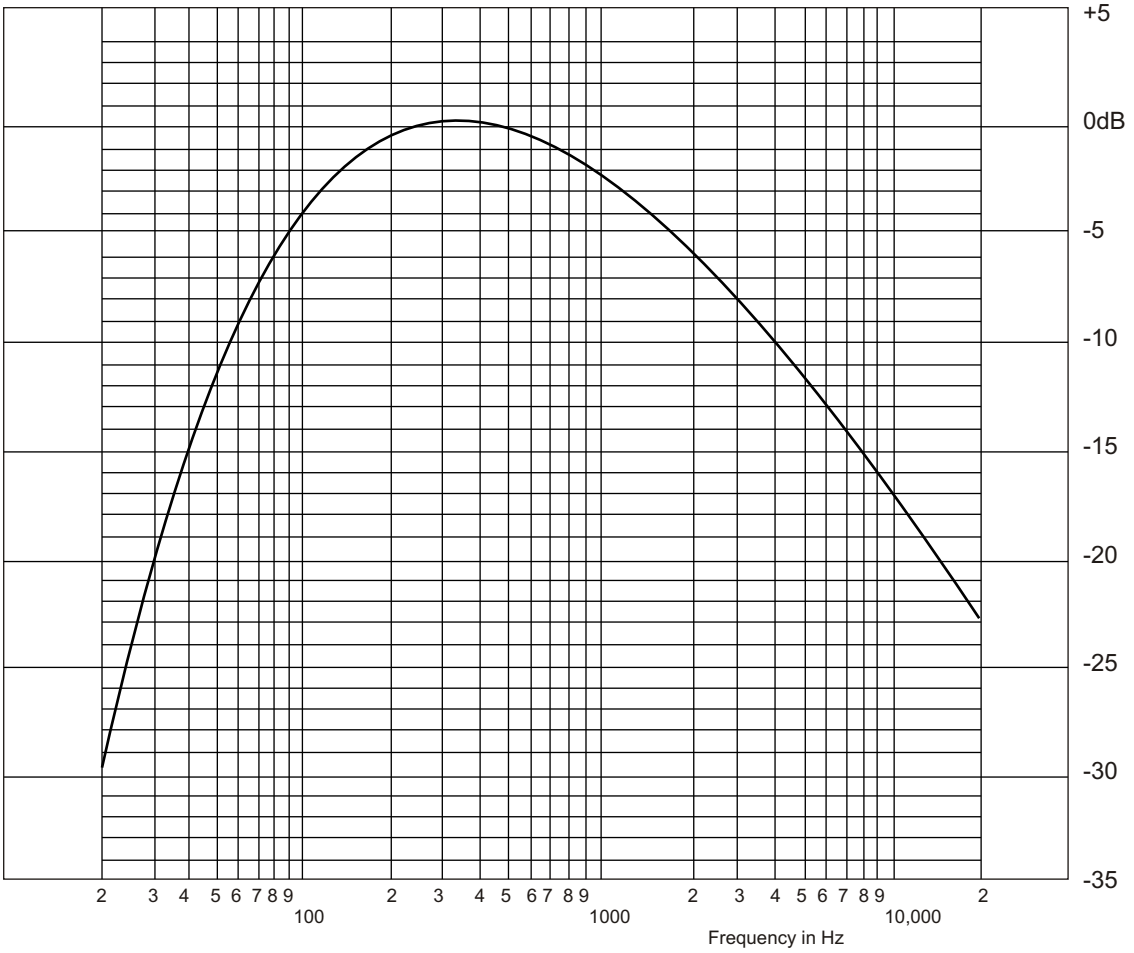


Fig. 5 DIN W & F Weighting Curve



4.3. WOW & FLUTTER (VT11-20)

The Wow & Flutter section has two distinct operations. 'Drift' gives an indication of the mean freqency of the replay signal, disregarding short term cyclic variations. This facility is normally used for checking the speed of an equipment against a known standard, the built-in W &F oscillator being nominally 3150Hz (3000Hz- suffix A) within 1%. The short term drift could vary by about 0.5% during use, after calibration in the morning following an initial warm-up period of approx. 10 minutes.

'W & F' gives the facility of measuring peak frequency excursions of the signal around 3150Hz or 3000Hz. All test sets will cover the range 3000-3150Hz for measuring wow and flutter without modification, the difference between RTS and RTSA being merely a change in frequency of the built-in W & F oscillator.

4.3.1. W & F Oscillator (VT11,12)

The transistors VT11/12 form a multivibrator whose frequency is set accurately by RV33; 'coarse' adjustment (such as converting from RTS to RTSA) can be made, if necessary, by simultaneously changing the values of R34/35. Provision has been made to modulate the frequency with a voltage inserted across R32 from the 'Cal' oscillator in order to set the peak W & F calibration. The output is modified to a sinewave by filter C24/L1/C25 and fed to the 'oscillator' output when the 'W & F drift' button is pressed.

4.3.2. W & F Meter (VT13-20)

For accurate measurement a signal of at least 50mV should be fed to R39, when the high frequencies are removed by C27 and low frequencies by C26. The residual carrier signal (at about 3kHz) is amplified by VT13 so that it is able to drive the monostable multivibrator VT14/15, resulting in a differentiated square wave at the collector of VT1S which is at the frequency of the original signal. This is differentiated by C31 and rectified by MR1 (positive half-cycle) and the emitter/base junction of VT16 (negative half-cycle). The pulse produced bottoms VT16 once every cycle and the average current through VT16 therefore depends linearly on the signal frequency only. The voltage developed across R46 is thus proportional to this frequency. Transistor VT17 forms a buffer, emitter-follower stage followed by a parallel -T filter to remove the carrier frequency, thus leaving the wow and flutter products and at the same time the response is altered so that after the W & F components have passed C40/R60 the response has been tailored to the DIN weighting curve shown in Fig. 5 . The signals are amplified by VT19 & 20 and fed to voltage doubler MR8 & 9, with the meter calibration adjusted by RV69. The DC level at the collector of VT16 corresponds to the mean frequency, and this is used for the 'drift' measurement, being compared via R52 to a fixed reference level set by RV56 when the 'drift' button is pressed.

FAULTS

There are no specific faults to suggest; malfunctions can be traced by following the signals through the circuit and comparing the waveforms shown on the oscilloscope with those shown in the full circuit diagram.

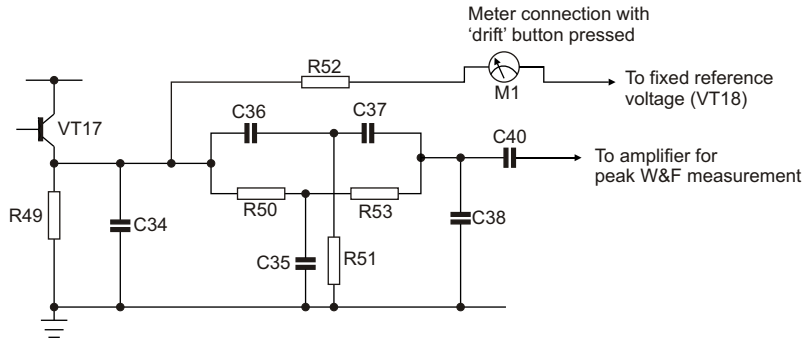


Fig.6 Circuit Detail - Wow & Flutter Meter

4.4. DISTORTION METER (VT33-37)

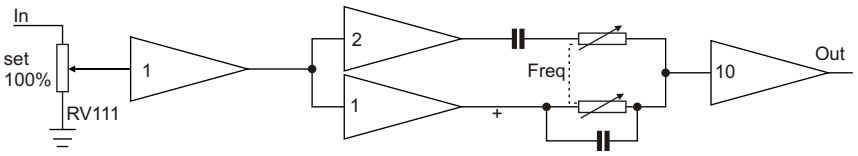


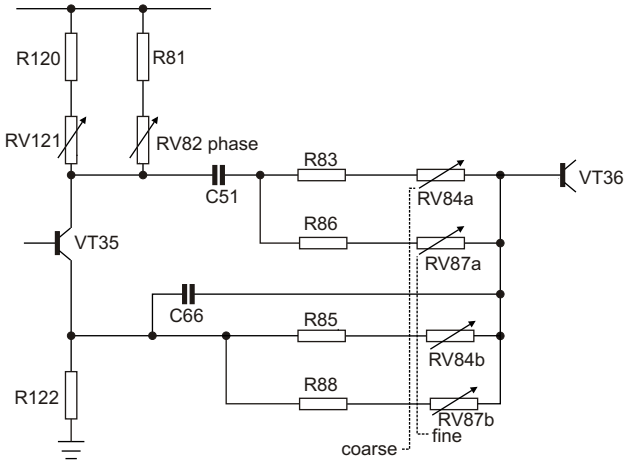
Fig. 7 Circuit Detail - Distortion Meter

The signal passes through potentiometer RV111 which sets the level into the dynamic emitter follower stage VT33. This stage has unity gain with VT34Lacting as a constant current load for VT33, the actual current being set by R113/R115. Bootstrapping through C64 is used to improve the input impedance, and MR22 provides protection for VT33 in the event of overload. VT33 is critical for noise and only low noise transistors should be used.

The base of transistor VT35 is a virtual earth point due to negative feedback via R124, which sets the gain of the amplifier stage to approx. 10. VT35 acts as a phase-splitter with emitter and collector loads, the ratio of their gains is approximately 2 :1 and set precisely by potentiometers in the collector load 'phase' potentiometers. The outputs are fed to a Wien Bridge having zero output at the selected frequency as
adjusted by the Balance phase and Frequency coarse/fine controls.

Pressing the '100%' button shorts out C64, thus removing the 'notch' in the response but leaving the gain unaffected. With the 'read' button pressed the notch in the response is reintroduced and C68 is shorted to earth, restricting the response to 20kHz. VT36 is an amplification stage with an overall gain of approx. 10, VT37 giving an emitter follower output via C69.

Fig. 8
Circuit Detail - Distortion Meter (Wien Bridge)



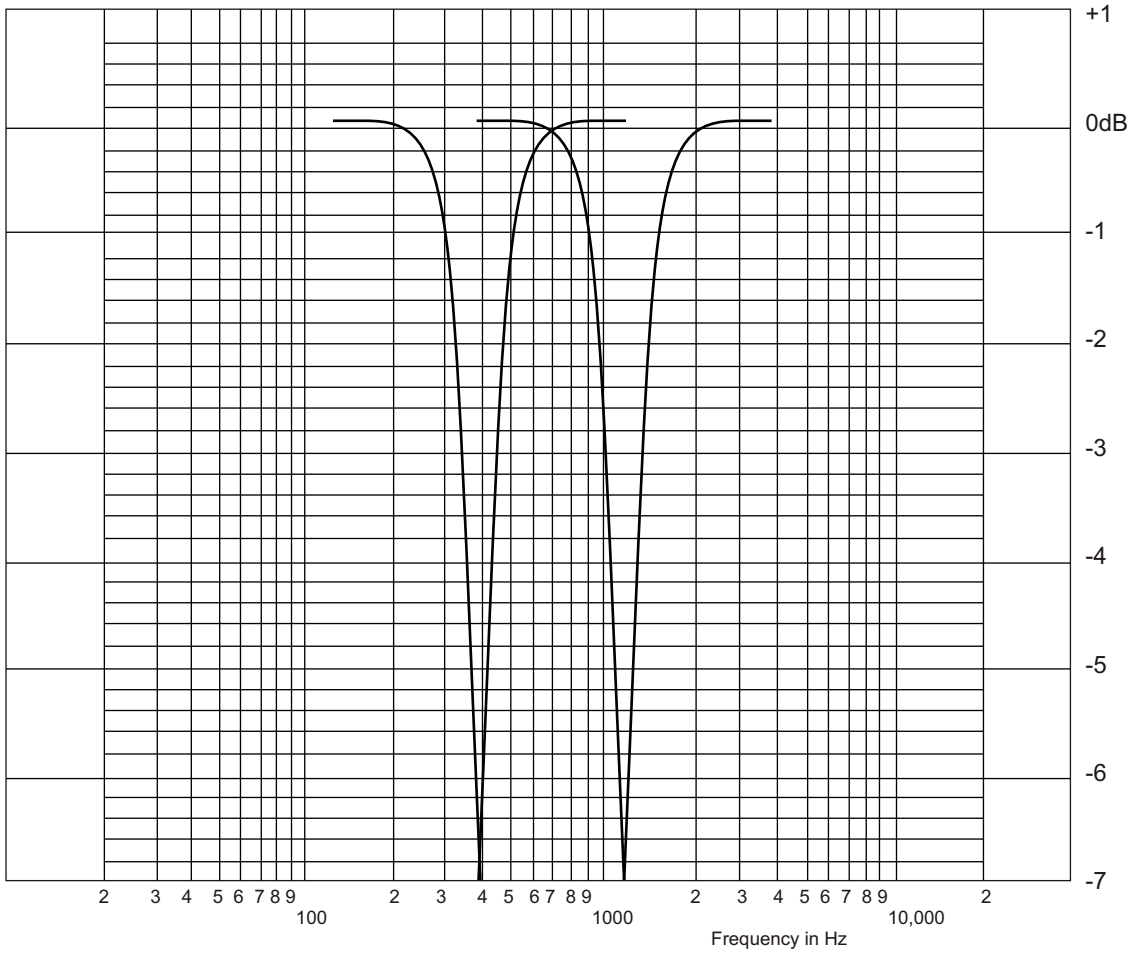
FAULT

Noise	VT33 is critical for noise, and only the specified transistor should be used. Certain components are more critical for noise - R114, R116, R117, R119, R120, R122.
Insufficient range on 'phase' control	Set RV121 so that meter 'nulls' when RV82 is five turns from one end viz. central.

4.5. CALIBRATION (VT31,32)
The 'Call oscillator is mounted on the Distortion Meter Board and consists of a multivibrator operating at approx. 70Hz. A 'square wave' output is taken from each collector, that from VT31 collector being used to modulate the W & F oscillator with calibration set by RV101. The output from VT32 is stabilised further by zener diode MR21 and further reduced to give an indication of 0dBm on 1V range of the millivoltmeter set by RV110 as a calibration standard.

The cal oscillator is only operational when the 'cal' button is pressed.

Fig. 9 Distortion Filter Response (Typical)



5. CALIBRATION

In the setting up of the RTS, it is necessary to use test instruments of sufficient accuracy to calibrate each section to the required performance. In general these should be of the order of ten times more accurate than the RTS, particularly the Millivoltmeter. In an emergency, less accurate test equipment may have to be used, but the accuracy of the RTS will then not necessarily conform exactly to specification and this must be borne in mind when making measurements.

5.1. Test Equipment Required

(a) Millivoltmeter	MV
(b) Digital Frequency Meter	DFM
(c) Distortion Meter	DM
(d) Oscilltor (sine wave)	0
(e) Oscilloscope	S
(f) Function Generator & LF Oscillator (see Wow & Flutter 5.6.3)	

5.2. Power Supply

(a) Using the Millivoltmeter MV, check that the voltage on the pin (red lead) of the Power Supply Board is 30V dc relative to chassis; if necessary reset RV192 on the Power Supply Board (Fig.10)

5.3. Oscillator

(a) Set the Oscillator output controls, Coarse & Fine, to maximum (fully clockwise) and set the dial and push button controls to give an output of 14kHz at the Oscillator output checked by the Frequency Meter DFM.
(b) Check that the dial indicates 14kHz; if necessary reset this by slackening the grub screw and rotating the dial to 14kHz before retightening (on later models remove the knob cover/insert, slacken the collet nut then retighten with the dial at 14kHz).
(c) Check that with the dial set to 4kHz the Frequency Meter DFM reading is within t 5% (3.8 to 4.2kHz).
(d) Check the frequency accuracy similarly on the other ranges.

Dial	Frequency Limits
4 kHz	3.8 kHz to 4.2 kHz
40 Hz	38 Hz to42 Hz
400 Hz	380 Hz to 420 Hz
40 kHz	38 kHz to 42 kHz

(e) Using the Millivoltmeter MV, check that the output from the oscillator with the coarse & fine controls at maximum is greater than 2.8V (at 1kHz approx.)

(f) Check that the 'Output' control 'Coarse' operates in steps of 10dB t 0.5dB.

(g) At 0dB on the 1V range of the Millivoltmeter MV, check that the frequency response is level at 1kHz, 15 Hz , 40Hz, 15kHz, 150kHz, within 0.2dB

(h) Set the oscillator output to 1V at 1kHz and using the Distortion Meter DM check that the distortion is less than .025%.

5.4. Millivoltmeter

(a) With nothing connected to the 'meter' socket and the milli-voltmeter set to the 30V range, check that the meter reads zero; if necessary reset the meter to zero using the adjustment at its rear.

(b) Feed the Oscillator 0 into both the RTS and the Millivolt-meter MV, setting each to the 1V range.

(c) Set the Oscillator 0 to lkHz and adjust its output to give a reading of 0.8V on the Millivoltmeter MV.

(d) Check that the RTS millivoltmeter also reads 0.8V; if necessary adjust the preset control 'mV meter cal' RV152 on the front panel.

(e) Check that the frequency response agrees with the Milli-voltmeter MV over the ranges 1kHz to 20kHz within ± 1% and over 15Hz to 150kHz within ± 2%; if necessary adjust trimmer capacitor C83 to give as level a high frequency response as possible.

(f) Recheck the reading of 0.8V (at 1kHz) on both meters; if necessary reset RV152.

(g) Press 'calibrate' and check that the RTS millivoltmeter reads 0dB (still on 1V range); if necessary reset RV110 on the Distortion Meter Board (then press 'calibrate' to release).

(h) With the Oscillator 0 set to 400Hz, press 'LF cut' and check that the response is reduced by 3dB (± 1dB).

(i) Reset the Oscillator 0 to 1kHz and adjust the output to give a meter reading of 0dB (on 1V); switching the input signal level in 10dB steps, check that on all ranges the RTS millivoltmeter agrees with the Millivoltmeter MV within ± 2% (one division of the top scale).

5.5. Distortion Meter

(a) It is not essential but nevertheless highly desirable that the Oscilloscope S be connected to the 'scope' socket throughout this section, thus enabling the output to be observed to ensure that it is signal rather than noise.

(b) Set the 'balance' controls to their centre positions ('Phase' control 5 complete turns from one end).

(c) With the Oscillator 0 still set to 1kHz, press 'set 100V and adjust the 'Sensitivity' control to give full scale reading on the 1V range.

(d) Press 'read' &'LF cut' and adjust the pre-set phase control RV121 on the Distortion Meter Board together with the 'freq coarse' & 'fine' controls on the front panel alternately to give minimum reading, reducing the milli-voltmeter range as required.

(e) If necessary, the final reading can be obtained using the 'phase' control on the front panel, but this must not be more than two full turns from its centre position.

(f) The final reading should be less than 0.025% (assuming that the inherent distortion of the Oscillator 0 is much less than this).

Note: Modification of RTS2 Distortion Measurement Frequency

The frequency range of the RTS2 distortion measurement can be modified to operate at a different frequency instead of the normal 400-1100Hz approximately by altering the value of C51 & C66 simultaneously. In practice the value of these capacitors is not critical, but they must have the same value within 1%. A suggested table of values is given below; values to give other frequency ranges can be determined by proportion.

C51& C66	Freq.Range
0.33 F	approx.
0.22 F	40 - 110 Hz*
0.1 F	60 - 165 Hz*
.056 F	132- 360 Hz*
.033 F	235- 650 Hz*
.022 F	400 -1100 Hz
.01 F	600 -1650 Hz
5600 pF	1.32- 3.6 kHz
3300 pF	2.35- 6.5 kHz
	4 - 11 kHz

*Because of the low frequency of operation after this modification has been carried out, the 'LF cut' button must not be pressed while making distortion measurements. The residual reading obtainable will therefore depend upon the level of hum, etc., in the signal and this will determine the minimum percentage distortion which can be read, although this will normally be adequate for most 'off tape' measurements.

5.6. Wow & Flutter Meter

5.6.1. Oscillator

(a) Connect the Digital Frequency Meter DFM to the 'oscillator' output, press 'W & F drift' and check the frequency of the W & F oscillator; if necessary adjust RV33 on the W & F Board to set the frequency to 3150Hz (or 3000Hz) ± 1%.

Note: If RV33 does not give enough adjustment, alter the values of R34/R35 simultaneously to bring the frequency within range (about 5-10% each should be sufficient), increasing the value to reduce the frequency and vice versa.

(b) Connect the Millivoltmeter MV to the 'oscillator' output and check that the output is 350mV or greater ; if necessary tune LI on the W & F Board for maximum output.

5.6.2. Drift

(a) Connect the Oscillator 0 and Digital Frequency Meter DFM in parallel across the 'meter' input and set the Oscillator 0 accurately to 3150Hz (or 3000Hz).

(b) Press 'W & F drift' and 'drift', and adjust the 'drift set zero' control RV56 to give zero drift on the meter (centre scale).

(c) Set the Oscillator 0 to ± 1% (3181.5Hz or 3030Hz) then to -1% (3118.5Hz or 2970Hz), and check that the meter reads accordingly; if necessary adjust the drift sensitivity potentiometer RV54 on the W& F Board to indicate ± 1% on the RTS meter scale.

(d) If RV44 has been adjusted, recalibrate zero drift as in (b) above and repeat (c); the settings of RV54 & RV56 are interdependent and (b) & (c) must be repeated alternately until no further adjustment is necessary.

(e) Remove the connections to the 'meter' socket on the RTS and press 'calibrate' (in addition to 'W & F drift').

(f) Check that the meter reads zero (centre scale); if necessary adjust 'drift set zero' pre-set control.

5.6.3. Wow & Flutter

(a) Connect to the RTS 'meter'• input a sine wave of 3150Hz (or 3000Hz) frequency modulated to 0.3% peak by a 4Hz sine wave; this can be obtained from a function generator and low frequency oscillator or another function generator.

(b) Press '0.3%' and check that the meter reads 0.3%; if necessary adjust the pre-set control 'peak wow-cal (0.3% range)' RV69.

(c) If available, connect the Oscilloscope S to the 'scope' socket and check that a sinusoidal wave form is shown.

(d) Press 'calibrate' and check that the meter reads on the 'cal' mark; if necessary, adjust the cal control RV101 (lower left) on the Distortion Meter Board.

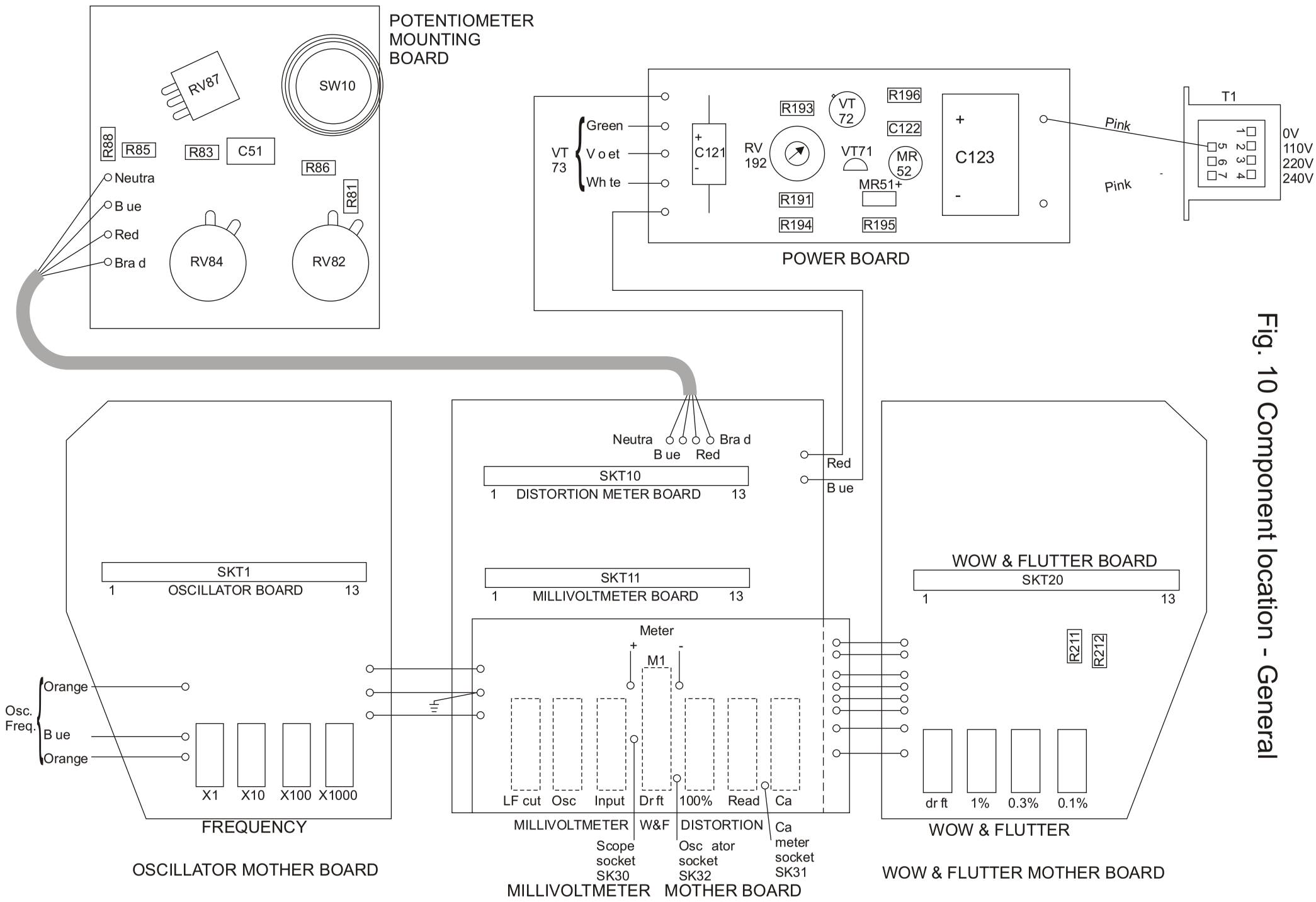


Fig. 10 Component location - General

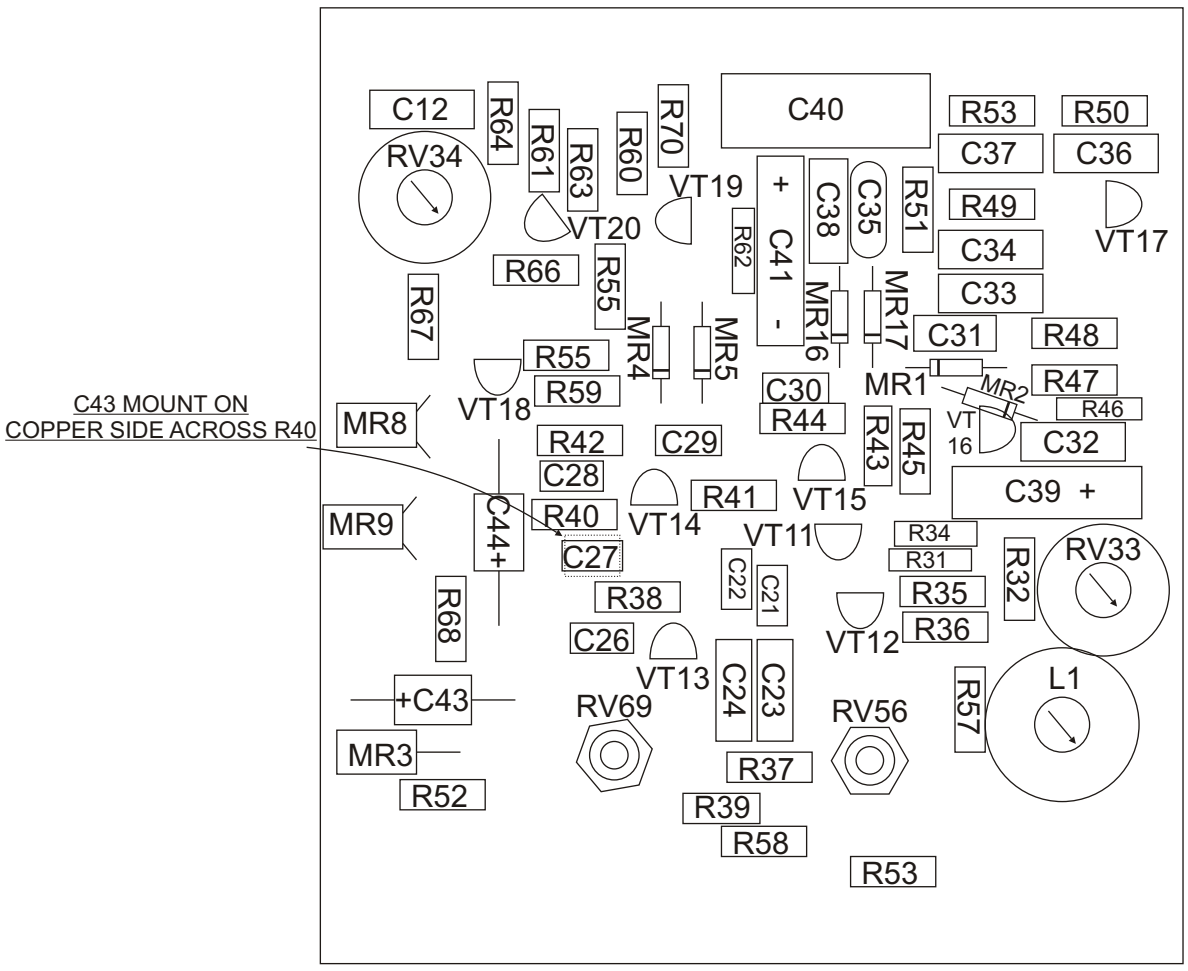


Fig. 11a Wow & Flutter Board
025 312

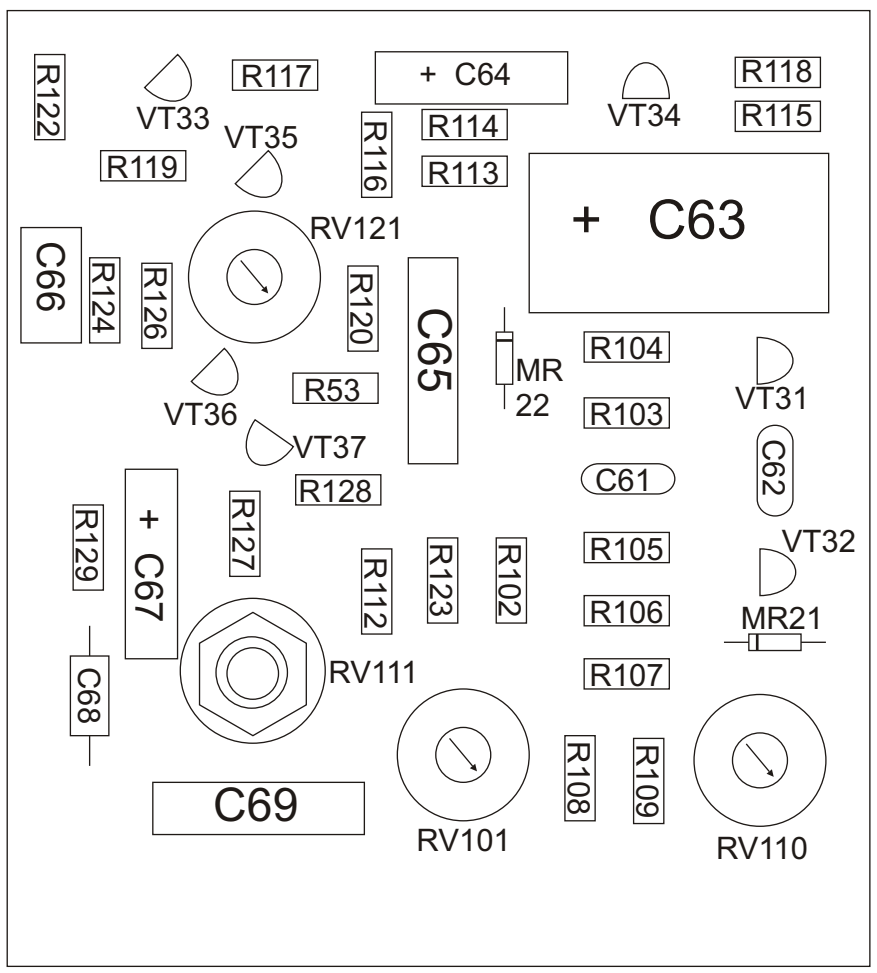


Fig. 11b Distortion Meter Board
025 320

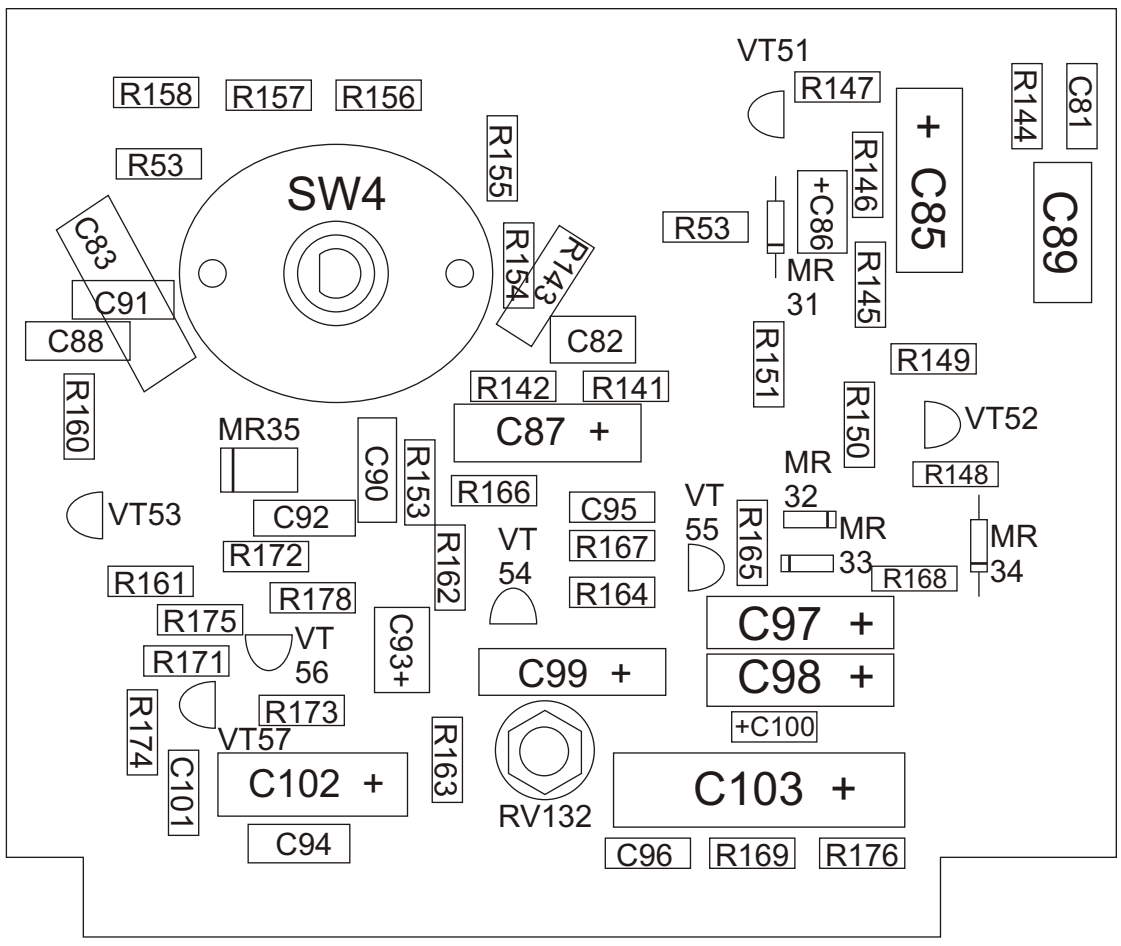


Fig. 11c Millivoltmeter Board
025 322

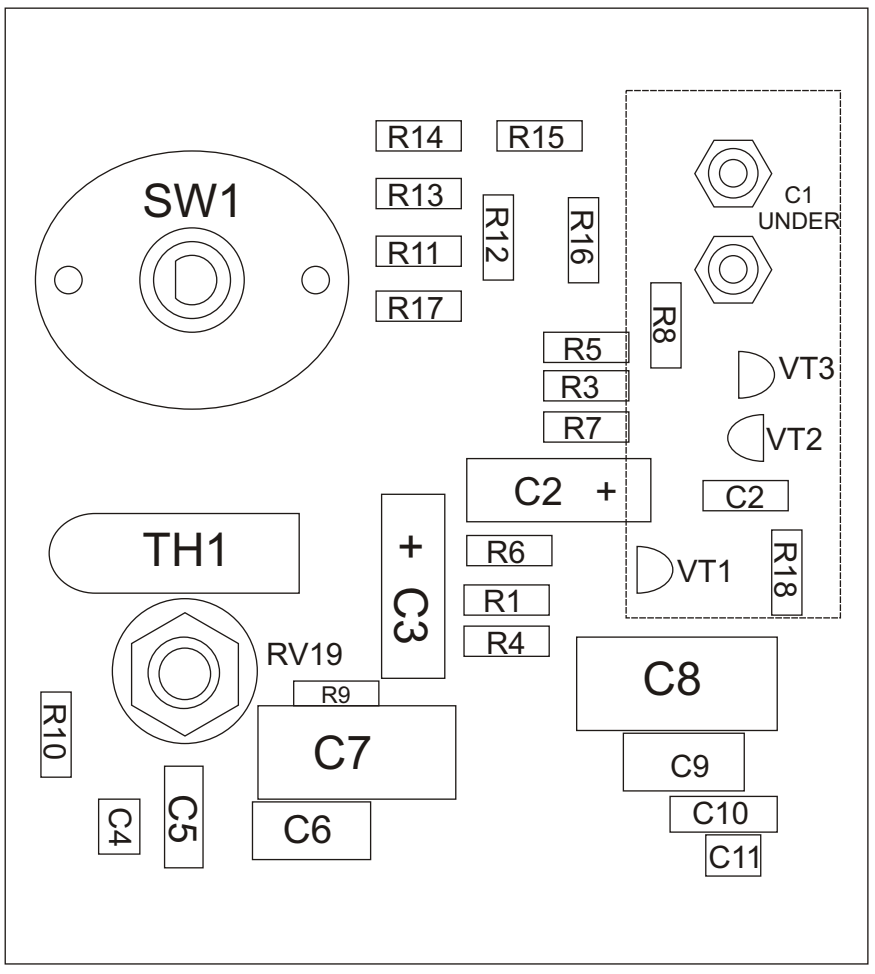


Fig. 11d Oscillator Board
025 245

Fig. 11 Component Location

6. HISTORY OF MODIFICATIONS

6.1 Mechanical

Date	Change No	Before	After	Comments
Jan.73	279	RV56,69,152-type 44(202-003)	Type 16 (coupling 202-005)	
Apr.73	299	Side panel 320-036	Side panel 320-047	
Jul.76	582	Millivoltmeter mother board	025-255 (Fixing modified)	Serial No. 3200+
	589	Control knob 448-025	Control knob 448-080	Item 9, Appdx. 1 Front view
	591	Handles, rear panel-dark grey	Handles, rear panel-light grey	
Mar.78	666	Extension spindles, couplers	Changed to suit potentiometers	See 6.2 & Appendix 1a
Feb.78	679	Control knob 448-080 (no longer manufactured)	Knob 448-087 Cap 448-088 Insert 440-038	See 589 above Items 9 & 10 of Front view Appendix 1 are 022-468
May 78	692	Rear panel 573-177 Issue 2 (Voltage selector deleted)	Rear panel 573-177 Issue 3 (Mains supply plug added)	Serial No. 4515+
			Rear panel 573-177 Issue 4 (VT73 transistor BD535)	See 6.2
Jul.78	702	Rear panel 573-177 Issue 3 (VT73 transistor 40312)	Front extrusion 573-179 (printing deleted)	Item 1, Appendix 4
Sep.78	716	Front extrusion 573-180		

6.2 Electrical

Date	Change No.	Cct. Ref.	Before	After	Comments
RTS 1					
May 71	136	R5	470R 0.5W 10% 625-13-470	560R 0.5W 5% 625-12-560	
		R43	360K 1% 625-24-360k	390k 1% 625-24-390k	
		R47	33k 0.5W 10% 625-13-33k	39k 0.5W 5% 625-12-39k	
		R48	47k 5% 624-001	56k 0.5W 5% 625-12-56k	
		R141	Not fitted	22R 0.5W 5% 625-12-22	
		C43,4	25 F 25V Electrolytic 130-016	12.5 F 25V Electrolytic 130-026	
		MR 2		Zener Diode BZY88C12 290-017	
May 71	142	C32	.022 F 131-255	0.047 F 131-256	
May 71	179	R40	56k 0.5W 5% 625-13-56k	47K 0.25W 5% 625-12-47K	
		C21,22	950pF 63V 21% 131-775	1000pF 63V 2.5% 131-768	
RTS 2 (Serial No. 730+)					
Aug.72	239	C45	Not fitted	950pF 63V 2.5% 131-775	Add to copper side of board.
Oct.72	251	R1	2.2k 1% 625-24-2k2	1.8k 1% 625-24-1k8	
		R4	1.8k 1% 625-24-1k8	1.6k 1% 625-24-1k6	
Jan.73	275	R176	180R 0.5W 5% 625-12-180	180R 0.25W 5% 625-07-180	
Jan.73	279	RV56	Type 44 + coupling 202-003	Type 16 + coupling 202-005	
		RV69	(spindle 0.125 in)	(spindle 4mm)	
		RV152	(fixing hole 0.25 in)	(fixing hole 7mm)	
Oct.73	370	C6,9	0.1 F 1%	0.1 F 100V 2% 131-514	
		C7,8	1 F 1%	1 F 100V 2% 131-515	
Nov73	396	C21,22	1000pF 64V 21% 131-768	950pF 63V 21% 131-775	

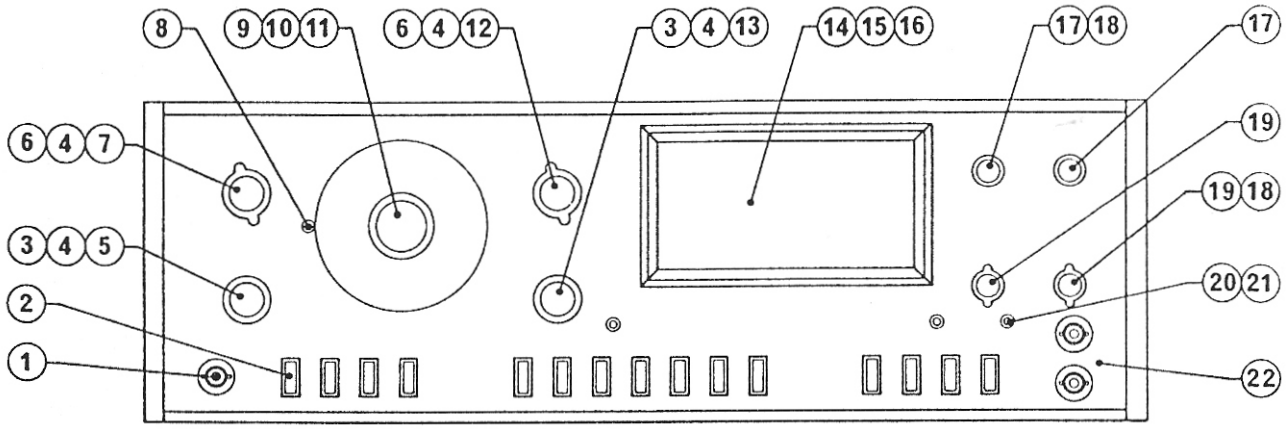
6.2 Electrical

Date	Change No.	Cct. Ref.	Before	After	Comments
May 75	510	R142 R143	R142 2k 0.25W 0.2% 624-016 R143 1M 0.25W 0.2% 624-017	1k 0.25W 0.2% 624-033 1M 0.25W 0.2% 624-032	No change necessary unless 'scope probe used prior to Serial No. 2700
June 76	576		Not fitted	Diode BAX16 290-001 or MAX16, or 1N4148 (pole SW6b earth)	Should be fitted to earlier models to avoid switching surges
July 76	589		582-033	582-033 (spindle reduced by 0.25in)	Later version fits all models.
May 78	666	RV87 RV19 RV111	582-034 582-035 582-036	582-109 + 705-028B = 022-528 582-107 + 705-028G = 022-527 582-108 + 705-028E = 022-526	Fit later assembly 022-XXX as replacement for earlier pot.
Jan 78	670	R8	47k 625-28-47k	10k 625-28-10k	
May 78	692	VS1	Voltage selector (no longer manufactured)	Ti Transformer tags	See Section 3.3 Serial No.4515+
		P1	Not fitted	Plug, power supply 577-017 Socket & lead 578-018 Label 450-171 “ 110V 50/60Hz 450-172 “ 220V 50/60Hz 450-173 “ 240V 50/60Hz 450-174	
July 78	702	VT73 FS1	VT73 Transistor 40312 825-002 Fuse 0.75A 380-008 Fuseholder 380-005	Transistor BD535 825-074 Fuse 1A 380-000 Fuse holder Bulgin 380-017 or (Schurter) 1380-017	

FERROGRAPH

RECORDER TEST SET

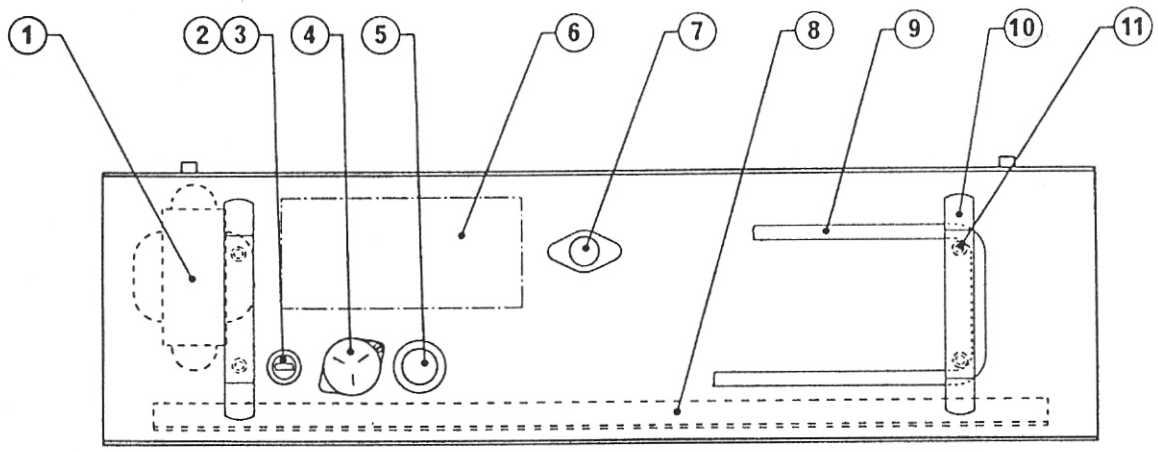
Appendix



FRONT VIEW RTS 2

Ref. Number	Item	Qty.	RTS2 Part No.
1	Socket	3	692-030
2	Button	15	448-019
3	Knob K2	2	448-021
4	Bush	4	100-037
5	Extension Spindle	1	705-028F
6	Knob K2W	2	448-023
7	Extension Spindle	1	705-028D
8	Zero Stud	1	666-071
9	Knob K3	1	448-080
10	Dial	1	295-004
11	Potentiometer 10k Logarithmic	1	582-033
12	Extension Spindle	1	705-028C
13	Extension Spindle	1	705-028E
14	Meter	1	512-005
15	Lamp Holder	1	455-008
16	Lamp Festoon 3W	1	455-010(12V)
17	Knob K1	2	448-022
18	Extension Spindle	2	705-028A
19	Knob K 1W	2	448-026
20	Bush	3	100-038
21	Extension Spindle	3	705-029
22	Front Panel	1	573-178

FERROGRAPH
RECORDER TEST SET
FERROGRAPH
RECORDER TEST SET

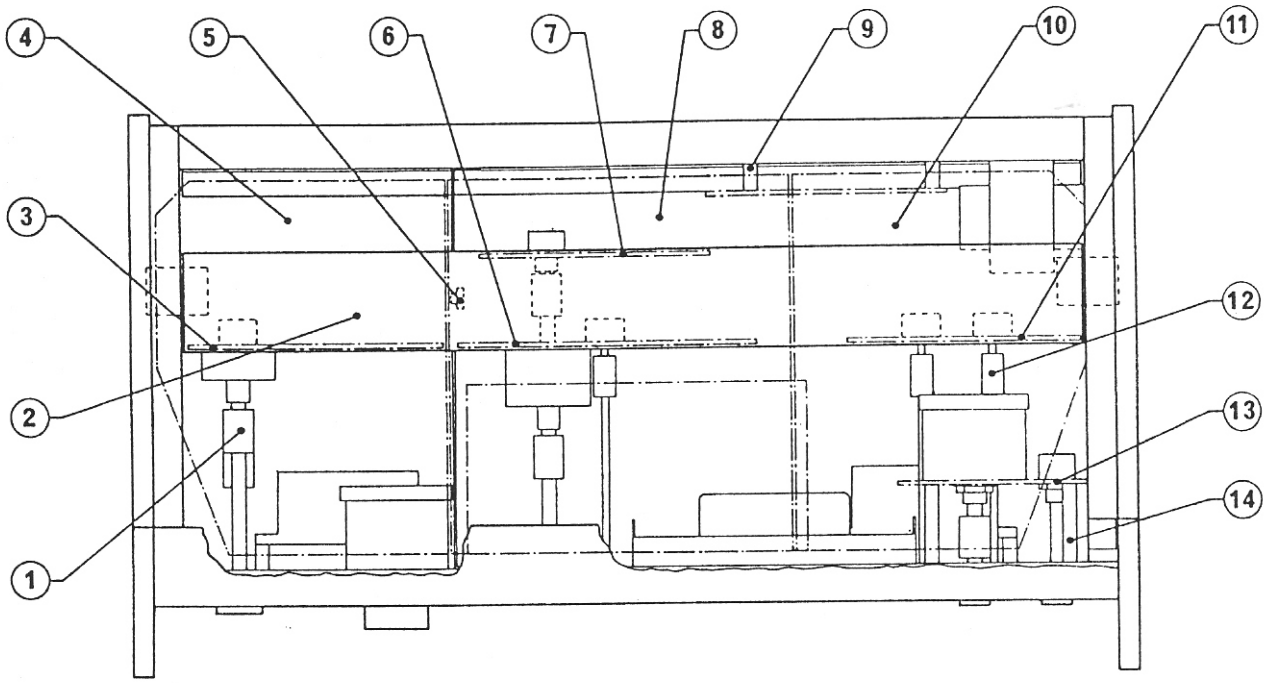


REAR VIEW

Ref. Number	Item	Qty.	RTS 2 Part No.
1	Mains Transformer	1	T1721
2	Fuse Holder	1	380-005
3	Fuse (0.75A, 20mm x 5mm dia.)	1	380-008
4	Vol tage Sel ector	1	920-001
5	Grommet	1	398-014
6	Power Board	1	025-310
7	Transistor (type 40312)	1	825-002
8	P.C. Board Support Bracket	1	025-255
9	Power Supply Lead	1	110-017
10	Cable Clip	2	196-011
11	Spacer	4	698-079

FERROGRAPH

RECORDER TEST SET

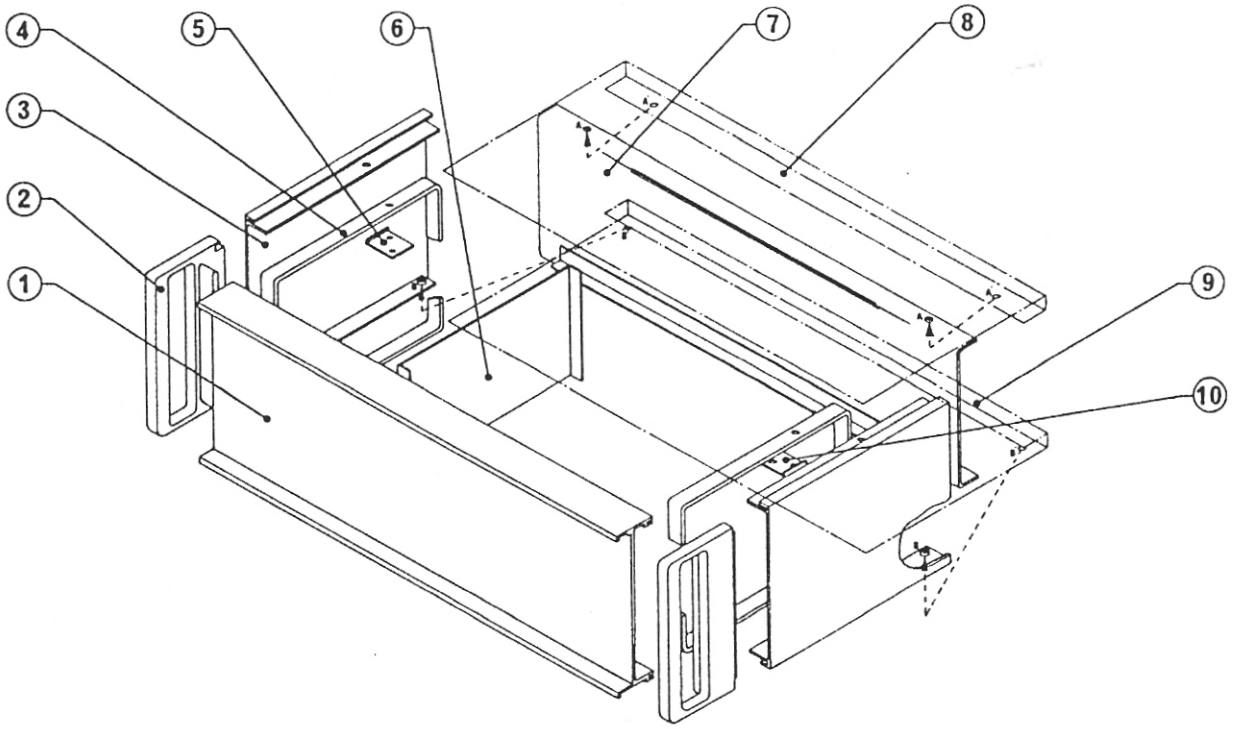


PLAN VIEW

Ref. Number	Item	RTS 2 Qty.	Part No.
1	Coupling	6	687-029
2	P. C. Board Fixing Strap	1	025-256
3	Oscillator Board	1	025-245
4	Oscillator Mother Board	1	025-247
5	Terminal Nut 4BA	1	BP/2025/N
6	Millivoltmeter Board	1	025-322
7	Distortion Meter Board	1	025-320
8	Millivoltmeter Mother Board	1	025-248
9	Spacer	9	698-068
10	Wow & Flutter Mother Board	1	025-311
11	Wow & Flutter Board	1	025-312
12	Coupling	3	202-005
13	Potentiometer Mounting Board	1	025-309
14	Spacer	4	698-069

FERROGRAPH

RECORDER TEST SET



EXPLODED VIEW RTS2

Ref. Number	Item	RTS2 Qty.	Part No.
1	Front Extrusion	1	573-180
2	Handle	2	412-002
3	Side Panel Extrusion	2	320-036
4	Hoop Frame	2	360-003
5	Bracket (top strap, L. H.)	1	025-254A
6	Screen	1	671-005
7	Rear Panel	1	573-177
8	Top Panel	1	573-143
9	Bottom Panel	1	573-144
10	Bracket (top strap, R. H.)	1	025-254B

FERROGRAPH
RECORDER TEST SET

List of Components

Cct. Ref.	OSCILLATOR BOARD			Part No.
	Resistors (R) & Potentiometers (RV)			
R1	1.8k	1/4W	1 % High Stab.	625 24 1k8
R2	15k	1/2W	10%	625 13 15k
R3	10k	1/2W	5%	625 12 10k
R4	1.6k	1/4W	1% High Stab.	625 24 1k6
R5	560R	1/2W	5%	625 12 560
R6	47k	1/2W	10%	625 13 47k
R7	820R	1/2W	5%	625 12 820
R8	47k	1/2W	10%	625 13 47k
R9	1k	1/4W	1% High Stab.	625 24 1k
R10	620R	1/2W	5%	625 12 620
R11	1370R	1/4W	0.2% High Stab.	624 015
R12	432R	1/4W	0.2% High Stab.	624 014
R13	137R	1/4W	0.2 % High Stab.	624 013
R14	43.2R	1/4W	0.2% High Stab.	624 012
R15	13.7R	1/4W	0.2% High Stab.	624 011
R16	6.34R	1/4W	0.2% High Stab.	624 010
R17	100R	1/2W	5%	625 12 100
R18	100R	1/2W	5%	625 12 100
RV19	2.2k0 Linear (OUTPUT fine)			582 035
	Capacitors			
Cl	3300 F 40V		Electrolytic	130 024
C2	125 F 16V		Electrolytic	130 002
C3	125 F 16V		Electrolytic	130 002
C4	950pF 30V		2 1/2%	131 775
C5	0.01 F 30V		2 1/2 %	131 774
C6	0.1 F	160V	2 1/2%	131 514
C7	1 F	160V	2 1/2%	131 515
CO	1 F	160V	2 1/2%	131 515
C9	0.1 F	160V	2 1/2%	131 514
CIO	0.01 F 30V		2 1/2%	131 774
C11	950pF	30V	2 1/2 %	131 775
	Miscellaneous			
VT1	Transistor BC183LB			825 015
VT2	Transistor BC154LB			825 016
VT3	Transistor BC183LB			825 015
SW1	Switch (OSC. OUTPUT coarse)			750 013
TH1	Thermistor ITT R25			800 000

Cct. Ref.	Front Panel	Part No
RV20a	10k0 Log. (FREQ.)	582 033
RV20b	10k Log	
	Miscellaneous	
MI	Meter (Sifam 100 A)	512 005
LP1	Lamp 12V, 3W	455 010
SKT30	Socket BNC (1637/CS)	692 030
SKT31	Socket BNC (1637/CS)	692 030
SKT32	Socket BNC (1637/CS)	692 030

Cct. Ref.	WOW & FLUTTER BOARD			Part No.
	Resistors (R) & Potentiometers (RV)			
R31	3.3k	1/2WW	5%	625 12 3k3
R32	1k0	1% High Stab.		625 24 1k
RV33	22k	Linear SET 3150Hz		582 012
R34	430k	0.25W 2% High Stab.		625 25 430k
R35	430k	0.25W 2% High Stab.		625 25 430k
R36	3k3	0.5W	5%	625 12 3k3
R37	5.6k	0.5W	5%	625 12 5k6
R38	10M	0.5W	10%	625 13 10M
R39	22k0	0.5W	10%	625 13 22k
R40	47k	0.25W 5% High Stab		624 001
R41	22k	0.5W 10%		625 13 22k
R42	3.3k	0.5W 5%		625 12 3k3
R43	390k	0.25W 1% High Stab		625 24 390k
R44	22k	0.5W 10%		625 I3 22k
R45	3.3k	0.5W 5%		625 12 3k3
R46	22k	0.25W 1% High Stab		625 24 22k
R47	39k	0.5W 5%		625 12 39k
R48	56k	0.5W 10%		625 13 56k
R49	22k	0.5W 10%		625 13 22k
R50	1k0	0.5W	10%	625 13 1k
R51	620R	0.5W	5%	625 12 620
R52	2.2k	0.25W 1% High Stab.		625 24 2k2
R53	1k	0.5W	10%	625 13 1k
RV54	1k	Linear DRIFT SENS.		582 032
R55	22k	0.5W	10%	625 13 22k
RV56	25k	Linear drift set zero		582 055
R57	22k	0.25W 1% High Stab.		625 24 22k
R58	33k	0.25W 1% High Stab.		625 24 33k
R59	33k	0.25W 1% High Stab.		625 24 33k
R60	100k	0.25W 5% High Stab.		624 002
R61	220k	0.5W	5%	625 12 220k
R62	1.6k	0.25W 1% High Stab.		625 24 11,6
R63	1M	0.5W	10%	625 13 1M
R64	4.7k	0.5W	5%	625 12 4k7
R65	390R	0.24W 1% High Stab.		625 24 390
R66	100k	0.25W 5% High Stab,		624 002
R67	1.6k	0.25W 1% High Stab.		625 24 1k6
R68	56k	0.5W	5%	625 12 56k
RV69	25k	Linear peak wow cal.		582 055
R70	470R	0.5W	10%	625 13 470
	Capacitors			
C21	950pF	63V	2i%	131 775
C22	950pF	63V	2%	131 775
C23	0.22µF	100V	10%	131 253
C24	0.220F	100V	10%	131 253
C25	O. 33pF	100V	10%	131 257
C26	950pF	63V	2 %	131 775
C27	950pF	63V	2 %	131 775
C28	950pF	63V	2 %	131 775
C29	950pF	63V	2 %	131 775

FERROGRAPH
RECORDER TEST SET

List of Components

Cct. Ref.	WOW & FLUTTER BOARD			Part No.
	Capacitors			
C30	950pF	63V	2%	131 775
C31	0.01pF 30V		2 %	131 774
C32	0.0470F 250V 10%			131 256
C33	0.22µF 100V 10%			131 253
C34	0.22pF 100V 10%			131 253
C35	0.1pF	100V 10%		131 250
C36	0.047µF 250V 10%			131 256
C37	0.047pF 250V 10%			131 256
C38	0.047µF 250V 10%			131 256
C39	25uF	25V	Electrolytic	130 016
C40	1uF	250V 10%		131 259
C41	25uF	25V	Electrolytic	130 016
C42	0.22µF 100y 10%			131 253
C43	12.5uF	25V	Electrolytic	130 026
C44	12.5uF	25V	Electrolytic	130 026
C45	950pF	63V	21%	131 775
	Miscellaneous			
VT11	Transistor BC184LC			825 005
VT12	Transistor BC184LC			825 005
VT13	Transistor BC184LC			825 005
VT14	Transistor BC 183LB			825 015
VT15	Transistor BC183LB			825 015
VT16	Transistor BC183LB			825 015
VT17	Transistor BC184LC			825 005
VT18	Transistor BC184LC			825 005
VT19	Transistor BC184LC			825 005
VT20	Transistor BC183LB			825 015
MR1	Diode MAX16			290 001
MR2	Zener Diode BZY88C12			290 017
MR3	Diode NKT249A30			290 015
MR4	Zener Diode BZY88C5V6			290 013
MR5	Zener Diode BZY88C4V7			290 016
MR6	Zener Diode BZY88C4V7			290 016
MR7	Zener Diode BZY88C4V7			290 016
MR8	Diode NKT 249A30			290 015
MR9	Diode NKT 249A30			290 015
L1	Coil			Spec 800
	POT. MOUNTING BOARD			
	Resistors (R) Er Potentiometers (RV)			
R81	10k	0.25W 1% High Stab.		625 24 10k
RV82	2k 10 turn BALANCE phase			582 056
R83	3.9k	0.5W	5%	625 12 3k9
RV84a	10k Log. (Freq. coarse)			582 094
RV84b	10k Log.			
R85	3.9k	0.5W	5%	625 12 3k9
R86	330k	0.5W	5%	625 12 330k
RV87a	100k Log. (Freq. fine)			582 034
RV87b	100k Log.			
R88	330k	0.5W	5%	625 12 330k

Cct. Ref.	POT. MOUNTING BOARD			Part No.
	Capacitors			
C51	0.033uF	250V 1%		131 260
	Miscellaneous			
SW10	Switch SUPPLY on			750 004
	DISTORTION METER BOARD			
	Resistors (R) & Potentiometers (RV)			
RV101	22k	Linear SET W&F CAL		582 012
R102	47k	0.25W	5% High Stab.	624 001
R103	47k	0.25W	5% High Stab.	624 001
R104	360k	0.25W	1% High Stab.	625 24 360k
R105	360k	0.25W	1% High Stab.	625 24 360k
R106	18k	0.5W	10%	625 13 18k
R107	4.7k	0.25W	1% High Stab.	625 24 4k7
R108	10k	0.25W	1% High Stab.	625 24 10k
R109	6k8	0.25W	1% High Stab.	625 24 6k8
RV110	22k Linear SET mVmeter CAL			582 012
RV111	100k Log. set 100%			582 036
RI12	1k	0.5W	10%	625 13 1k
R113	22k	0.25W	1% High Stab.	625 24 22k
R114	33k	0.25W	1% High Stab.	625 24 33k
R115	1.8k	0.5W	10%	625 12 1k8
R116	22k	0.25W	1% High Stab.	625 24 22k
R117	47k	0.25W	1% High Stab.	624 001
R118	100R	0.5W	5%	625 12 100
R119	3.3k	0.5W	5%	625 12 3k3
R120	1.8k	0.25W	1% High Stab.	625 24 1k8
RV121	1k Linear SET PHASE BAL.			582 032
R122	1k	0.25W	1% High Stab.	625 24 1k
R123	1.8k	0.5W	5%	625 12 1k8
R124	39k	0.5W	10%	625 13 39k
R125	100k	0.25W	5% High Stab.	624 002
R126	270R	0.5W	5%	625 12 270
R127	47k	0.25W	5% High Stab.	624 001
R128	10k	0.5W	10%	625 13 10k
R129	1.5k	0.5W	5%	625 12 1k5
	Capacitors			
C61	0.1uF	100V	10%	131 250
C62	0.1uF	100V	10%	131 250
C63	640uF	25V	Electrolytic	130 004
C64	25uF	25V	Electrolytic	130 016
C65	0.47uF	250V	10%	131 258
C66	0.033uF	250V	10%	131 262
C67	25uF	25V	Electrolytic	130 016
C68	4700pF	30V	21/2%	131 778
C69	0.47uF	250V	10%	1310258

FERROGRAPH
RECORDER TEST SET

List of Components

Cct. Ref.	DISTORTION METER BOARD	Part No.
	Miscellaneous	
VT31	Transistor BC183LB	825 015
VT32	Transistor BC183LB	825 015
VT33	Transistor 2 SC 1000BL	825 035
VT34	Transistor BC183LB	825 015
VT35	Transistor 2 SC 1000 BL	825 035
VT36	Transistor 2 SC 1000 BL	825 035
VT37	Transistor 2 SC 1000 BL	825 035
MR21	Zener Diode BZY88C5V6	290 013
MR22	Diode MAX 16	290 001

Cct. Ref.	MILLIVOLTMETER BOARD	Part No.
R141	22R 0.5W 5%	625 12 22
R142	2K 0.5W 0.2% High Stab	624 16
R143	2M 0.5W 0.2% High Stab	624 17
R144	1K 0.5W 5%	625 12 1K
R145	180R 0.5W 1% High Stab	625 24 180
R146	1K 0.5W 5%	625 12 1K
R147	10K 0.5W 5%	625 12 10K
R148	1K 0.5W 1% High Stab	625 24 1K
R149	270K 0.5W 5%	625 12 270K
R150	1.5K 0.5W 1% High Stab	625 24 1.5K
R151	470R 0.5W 5%	625 13 470
RV152	2K Linear MVmeter Cal.	528 054
R153	6.34R 0.5W 0.2% High Stab	624 010
R154	33.7R 0.5W 0.2% High Stab	624 011
R155	43.2R 0.5W 0.2% High Stab	624 012
R156	137R 0.5W 0.2% High Stab	624 013
R157	432R 0.5W 0.2% High Stab	624 014
R158	1370R 0.5W 0.2% High Stab	624 015
R159	470R 0.5W 0.2% High Stab	625 13 470
R160	10M 0.5W 10%	625 13 10M
R161	100K 0.5W 5% High Stab	624 002
R162	100K 0.5W 5% High Stab	624 002
R163	47R 0.5W 1% High Stab	625 24 47
R164	470K 0.5W 10%	625 13 470K
R165	620R 0.5W 5%	625 12 620
R166	10K 0.5W 5%	625 12 10K
R167	1.5K 0.5W 10%	625 13 1.5K
R168	1K 0.5W 1% High Stab	625 24 1K
R169	1K 0.5W 1% High Stab	625 24 1K
R170	100R 0.5W 5%	625 12 100
R171	220K 0.5W 10%	625 13 220K
R172	470K 0.5W 10%	625 13 470K
R173	1K 0.5W 5%	625 12 1K
R174	15K 0.5W 5%	625 12 15K

Cct. Ref.	MILLIVOLTMETER BOARD	Part No.
	Resistors (R) & Potentiometers (RV)	
R175	10k 0.5W 5%	625 12 10k
R176	180R 0.5W 5%	625 07 180
	Capacitors	
C81	500pF 160V 10%	131 765
C82	0.01µF 30V 2.5%	131 774
C83	Variable Ceramic	131 001
C84	160uF 25V Electrolytic	130 011
C85	125uF 16V Electrolytic	130 002
C86	5uF 64V Electrolytic	130 007
C87	32uF 40V Electrolytic	130 013
C88	0.22uF 100V 10%	131 253
C89	0.1µF 400V 10%	131 516
C90	0.022uF 250V 10%	131 255
C91	0.22uF 100V 10%	131 253
C92	0.22uF 100V 10%	131 253
C93	5uF 64V Electrolytic	130 007
C94	0.047uF 250V 10%	131 256
C95	0.1uF 100V 10%	131 250
C96	500pF 160V 10%	131 765
C97	25uF 25V Electrolytic	130 016
C98	25uF 25V Electrolytic	130 016
C99	25uF 25V Electrolytic	130 016
C100	12.5uF 25V Electrolytic	130 026
C101	0.22uF 100V 10%	131 253
C102	125uF 16V Electrolytic	130 002
C103	160uF 25V Electrolytic	130 011
	Miscellaneous	
VT51	Transistor 2SK30GR	825 006
VT52	Transistor BC 184LC	825 005
VT53	Transistor BC183LB	825 015
VT54	Transistor BC183LB	825 015
VT55	Transistor BC183LB	825 015
VT56	Transistor BC183LB	825 015
VT57	Transistor BC183LB	825 015
MR31	Zener Diode BZY88C5V6	290 013
MR32	Diode MAX16	290 001
MR33	Diode MAX16	290 001
MR34	Diode MAX16	290 001
MR35	Zener Diode BZX70C20 (or 3TZ20 or 1N5357B)	290 011
SW6	Switch M1LLIVOLTMETER	750 014
	POWER BOARD	
	Resistors (R) & Potentiometers (RV)	
R191	22k 0.5W 1% High Stab.	625 24 22k
RV192	1k0 Linear SET 30V D.C.	582 032
R193	4.3k 0.5W 1% High Stab.	625 24 4k3
R194	3.9K 0.5W 5%	625 12 3k9
R195	100k 0.5W 10%	625 13 100k
R196	10k 0.5W 10%	625 13 10k

FERROGRAPH
RECORDER TEST SET

List of Components

Cct. Ref.		POWER BOARD	Part No.
		Capacitors	
C121	100uF	40V Electrolytic	130 001
0122	0.01uF	100V 10%	131 500
C123	250uF	64V Electrolytic	130 010
		Miscellaneous	
VT71	Transistor BC183LB		825 015
VT72	Transistor BC461		825 032
MR51	Zener Diode BZY88C5V6		290 013
MR52	Bridge Rectifier W02		600 002
		REAR PANEL.	
VT73	Transistor 40312		825 002
T1	Transformer, Power Supply		T1721
FS1	Fuse 0.75A, 20mm x 5mm dia.		380 008
VS	Voltage Selector		920 001

Cct. Ref.		W F MOTHER BOARD	Part No.
R211	680R	0.5W 1% High Stab.	625 24 680
R212	137R	0.5W 0.2% High Stab.	624 013
SW25	Push Button Switch W & F		749 005
SKT20	P. C. Board Socket 26 way		692 029
		OSCILLATOR MOTHER BOARD	
SW15	Push Button Switch FREQUENCY		749 005
SKT1	P.C. Board Socket 26 way		692 029
		MILLIVOLTMETER MOTHER BD	
SW20	Push Button Switch		749 003
SKT10	P.C. Board Socket 26 way		692 029
SKT11	P.C. Board Socket 26 way		692 029

REPLACEMENT BOARD SERVICE

Where it is found necessary to change an electronic component, the RTS2 should be checked and re-calibrated using test equipment which is several times more accurate than the Test Set itself. If this equipment is not available or if difficulty is experienced, the relevant P.C. board(s) can be sent for checking or replacement to the Ferrograph !Replacement Board Service!.

When returning the board(s) to the appropriate overseas agent, or in the U.K. to theU. K. SERVICE DEPARTMENT . It is essential to include the SERIAL NUMBER of the Test Set.

FERROGRAPH RECORDER TEST SET
RTS2

Serial No. 4515 onwards

CIRCUIT DIAGRAM

250-042 Issue 5

SWITCH INDEX SHOWING
POLE CONTACT RELATIONSHIP

POLE CONTACT

DEPRESSED RELEASED

FREQUENCY
X1 X10 X100 X1000

MILLIVOLTMETER W&F DISTORTION CAL
L.F.cut osc input drift 100% read

WOW & FLUTTER
drift 1% 0.3% 0.1%

SET W&F CAL

SET MV METER CAL

freq. coarse

freq. fine

mV meter cal (1V range)

12 POSN. SWITCH ONLY 6 TAGS SHOWN. OPPOSITE TAGS LINKED

SET 30V

NEUTRAL

LIVE

SUPPLY ON